

What is claimed is:

1. An air-fuel ratio sensor comprising:

a cylindrical housing having a first end and an opposite second end;

5 an air-fuel ratio sensor element inserted through the cylindrical housing and capable of detecting an air-fuel ratio in an atmosphere of unburnt gas, the sensor element having a detecting portion for performing detection of the air-fuel ratio;

an atmospheric side cover disposed on the first end of the cylindrical housing and defining an inside chamber for storing therein atmospheric air; and

a measured gas side cover disposed on the second end of the cylindrical housing so as to cover the air-fuel ratio sensor element and defining an inside chamber for storing therein a gas to be measured,

15 wherein the measured gas side cover has a nested structure composed of a plurality of cup-shaped cover members disposed one inside another, each of the cup-shaped cover members having a gas inlet hole formed in a side wall thereof for introducing the measured gas into the inside chamber of the measured gas side cover, and a bottom hole formed in a bottom wall thereof, and

wherein the gas inlet hole of an innermost one of the plurality of cover members that directly faces the air-fuel ratio sensor element is offset from the detecting portion of the air-fuel ratio sensor element toward the housing in an axial direction of the air-fuel ratio sensor.

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2. The air-fuel ratio sensor according to claim 1, wherein the cylindrical housing has an end face facing the inside chamber of the measured gas side

cover at the second end of the housing, the detecting portion of the air-fuel ratio sensor element is spaced from the end face of the housing by a distance in the axial direction of the sensor, and the gas inlet hole of the innermost cover member has a center located offset from a midpoint of the distance toward the end face of the housing in the axial direction of the sensor.

3. The air-fuel ratio sensor according to claim 1, wherein the total area of the gas inlet hole of each cover member has a minimum value in the range of 0.3 to 12 mm<sup>2</sup>.

4. The air-fuel ratio sensor according to claim 1, wherein the total area of the bottom hole of each cover member has a minimum value in the range of 0.3 to 12 mm<sup>2</sup>.

5. The air-fuel ratio sensor according to claim 1, further comprising a partition structure for blocking flow communication of the measured gas between the gas inlet hole of each cover member and the bottom hole of each cover member.

6. The air-fuel ratio sensor according to claim 5, wherein the plurality of cover members of the measured gas side cover include an inner cover member forming the innermost cover member, an outer cover member disposed outside the inner cover member with a bottom wall thereof held in close contact with a bottom wall of the inner cover member, and an explosionproof cover disposed outside the outer cover member with a bottom wall thereof separated from the bottom wall of the outer cover member, the partition structure includes the bottom walls of the inner and outer cover members held in close contact with

each other, and a partition plate hermetically fitted in the explosionproof cover member and held in close contact with the bottom wall of the explosionproof cover member.

5     7. The air-fuel ratio sensor according to claim 6, wherein the partition plate has an outer peripheral portion extending obliquely from the bottom wall of the outer cover member toward the bottom wall of the explosionproof cover member.

10    8. The air-fuel ratio sensor according to claim 5, wherein the plurality of cover members of the measured gas side cover include an inner cover member forming the innermost cover member, an outer cover member disposed outside the inner cover member with a bottom wall thereof held in close contact with a bottom wall of the inner cover member, and an explosionproof cover disposed  
15 outside the outer cover member with a bottom wall thereof separated from the bottom wall of the outer cover member, and the partition structure includes the bottom walls of the inner and outer cover members held in close contact with each other, and a ring-shaped partition plate hermetically fitted in an annular space defined between the explosionproof cover member and the outer cover  
20 member and located adjacent to the bottom wall of the outer cover member.

9. The air-fuel ratio sensor according to claim 5, wherein the plurality of cover members of the measured gas side cover include an inner cover member forming the innermost cover member, an outer cover member disposed outside  
25 the inner cover member with a bottom wall thereof held in close contact with a bottom wall of the inner cover member, and an explosionproof cover disposed outside the outer cover member with a bottom wall thereof separated from the

bottom wall of the outer cover member, and the partition structure includes the bottom walls of the inner and outer cover members held in close contact with each other, and a truncated hollow cone hermetically fitted in an annular space defined between the explosionproof cover member and the outer cover member and having a small diameter end engaged with a side wall the outer cover adjacent to the bottom wall of the outer cover member and an large diameter end engaged with a side wall of the explosionproof cover member adjacent to the bottom wall of the explosionproof cover member.

- 10 10. The air-fuel ratio sensor according to claim 5, wherein the plurality of cover members of the measured gas side cover include an inner cover member forming the innermost cover member, an outer cover member disposed outside the inner cover member with a bottom wall thereof held in close contact with a bottom wall of the inner cover member, and an explosionproof cover disposed outside the outer cover member with a bottom wall thereof separated from the bottom wall of the outer cover member, and the partition structure includes the bottom walls of the inner and outer cover members held in close contact with each other, and a part of a side wall of the explosionproof cover member being constricted in a radial inward direction so such that the constricted part of the side wall is in close contact with the bottom wall of the outer cover member.

11. The air-fuel ratio sensor according to claim 5, wherein the plurality of cover members of the measured gas side cover include an inner cover member forming the innermost cover member, an outer cover member disposed outside the inner cover member with a bottom wall thereof held in close contact with a bottom wall of the inner cover member, and an explosionproof cover disposed outside the outer cover member with a bottom wall thereof held in close contact

with the bottom wall of the outer cover member, and the partition structure includes the bottom walls of the inner, outer and explosionproof cover members held in close contact with each other.

5     12. The air-fuel ratio sensor according to claim 1, wherein the plurality of cover members include an outer cover member disposed immediately outside the innermost cover member, and the gas inlet hole of the outer cover member is offset from the air-fuel ratio detecting portion of the sensor element in a direction away from the housing.

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13. The air-fuel ratio sensor according to claim 1, wherein the air-fuel ratio sensor element comprises a cup-shaped sensor element or a laminated type sensor element.

15     14. The air-fuel ratio sensor according to claim 1, wherein the air-fuel ratio sensor element comprising a laminated type sensor element, and the plurality of cover members of the measured gas side cover each have a quadrangular shape in cross section.

20     15. The air-fuel ratio sensor according to claim 1, wherein the sensor is disposed in a surge tank for performing measurement of an air-fuel ratio in an evaporated gas.

16. The air-fuel ratio sensor according to claim 1, wherein the sensor is  
25     disposed in an exhaust manifold of a diesel engine for performing measurement of an air-fuel ratio in an exhaust gas containing a combustible gas added to on an exhaust side of the diesel engine.

17. An air-fuel ratio sensor comprising:

an air-fuel ratio sensor element capable of detecting an air-fuel ratio in an atmosphere of unburnt gas and having an air-fuel ratio detecting portion for performing detection of the air-fuel ratio; and

5 a heater for keeping the temperature of the air-fuel ratio detecting portion of the sensor element above 800°C during measurement of the air-fuel ratio.

18. The air-fuel ratio sensor according to claim 17, wherein the temperature of  
10 the air-fuel ratio detecting portion of the sensor element is below 1000°C.

19. The air-fuel ratio sensor according to claim 17, wherein the air-fuel ratio sensor element comprises a cup-shaped sensor element or a laminated type sensor element.

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20. The air-fuel ratio sensor according to claim 17, wherein the sensor is disposed in a surge tank for performing measurement of an air-fuel ratio in an evaporated gas.

20 21. The air-fuel ratio sensor according to claim 17, wherein the sensor is disposed in an exhaust manifold of a diesel engine for performing measurement of an air-fuel ratio in an exhaust gas containing a combustible gas added to on an exhaust side of the diesel engine.

25 22. An air-fuel ratio sensor comprising:

a cylindrical housing having a first end and an opposite second end;

an air-fuel ratio sensor element inserted through the cylindrical

housing and capable of detecting an air-fuel ratio in an atmosphere of unburnt gas, the sensor element having a detecting portion for performing detection of the air-fuel ratio;

an atmospheric side cover disposed on the first end of the cylindrical housing and defining an inside chamber for storing therein atmospheric air; and

a measured gas side cover disposed on the second end of the cylindrical housing so as to cover the air-fuel ratio sensor element and defining an inside chamber for storing therein a gas to be measured,

wherein the measured gas side cover has a nested structure composed of a plurality of cup-shaped cover members disposed one inside another, each of the cup-shaped cover members having a gas inlet hole formed in a side wall thereof for introducing the measured gas into the inside chamber of the measured gas side cover, and a bottom hole formed in a bottom wall thereof, and

wherein a portion of the air-fuel ratio sensor element that is disposed in face to face with the gas inlet hole of an innermost cover member of the plurality of cover members has a temperature made higher than a temperature of the detecting portion of the air-fuel ratio sensor element during measurement of the air-fuel ratio.

23. The air-fuel ratio sensor according to claim 22, wherein the air-fuel ratio sensor element comprises a cup-shaped sensor element or a laminated type sensor element.

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24. The air-fuel ratio sensor according to claim 22, wherein the air-fuel ratio sensor element comprising a laminated type sensor element, and the plurality

of cover members of the measured gas side cover each have a quadrangular shape in cross section.

25. The air-fuel ratio sensor according to claim 22, wherein the sensor is  
5 disposed in a surge tank for performing measurement of an air-fuel ratio in an evaporated gas.

26. The air-fuel ratio sensor according to claim 22, wherein the sensor is  
disposed in an exhaust manifold of a diesel engine for performing measurement  
10 of an air-fuel ratio in an exhaust gas containing a combustible gas added to on an exhaust side of the diesel engine.

27. An air-fuel ratio sensor comprising:

a cylindrical housing having a first end and an opposite second end;

15 an air-fuel ratio sensor element inserted through the cylindrical housing and capable of detecting an air-fuel ratio in an atmosphere of unburnt gas;

an atmospheric side cover disposed on the first end of the cylindrical housing and defining an inside chamber for storing therein atmospheric air;

20 and

a measured gas side cover disposed on the second end of the cylindrical housing so as to cover the air-fuel ratio sensor element and defining an inside chamber for storing therein a gas to be measured,

wherein the measured gas side cover has a nested structure composed  
25 of a plurality of cup-shaped cover members disposed one inside another, and each of the cup-shaped cover members has a catalytic layer disposed over a surface thereof.



28. The air-fuel ratio sensor according to claim 27, wherein the air-fuel ratio sensor element comprises a cup-shaped sensor element or a laminated type sensor element.
- 5 29. The air-fuel ratio sensor according to claim 27, wherein the air-fuel ratio sensor element comprising a laminated type sensor element, and the plurality of cover members of the measured gas side cover each have a quadrangular shape in cross section.
- 10 30. The air-fuel ratio sensor according to claim 27, wherein the sensor is disposed in a surge tank for performing measurement of an air-fuel ratio in an evaporated gas.
31. The air-fuel ratio sensor according to claim 27, wherein the sensor is  
15 disposed in an exhaust manifold of a diesel engine for performing measurement of an air-fuel ratio in an exhaust gas containing a combustible gas added to on an exhaust side of the diesel engine.
32. An air-fuel ratio sensor comprising:
- 20 an air-fuel ratio sensor element capable of detecting an air-fuel ratio in an atmosphere of unburnt gas, the sensor element having a trap layer of porous ceramics disposed over a surface thereof and having a thickness not less than 10  $\mu\text{m}$ .
- 25 33. The air-fuel ratio sensor according to claim 32, wherein the thickness of the trap layer is not greater than 100  $\mu\text{m}$ .

34. The air-fuel ratio sensor according to claim 32, wherein the air-fuel ratio sensor element comprises a cup-shaped sensor element or a laminated type sensor element.

5 35. The air-fuel ratio sensor according to claim 32, wherein the sensor is disposed in a surge tank for performing measurement of an air-fuel ratio in an evaporated gas.

10 36. The air-fuel ratio sensor according to claim 32, wherein the sensor is disposed in an exhaust manifold of a diesel engine for performing measurement of an air-fuel ratio in an exhaust gas containing a combustible gas added to on an exhaust side of the diesel engine.